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MOLLUSCA OF THE GREAT SMOKY MOUNTAINS.

BY HENRY A. PILSBRY.

The material recorded and described in this paper was gathered by a party of five naturalists, Messrs. J. H. Ferriss, Bryant Walker, George H. Clapp, H. E. Sargent and myself, who visited the mountains in July and August of 1899.¹ Some account of the wanderings and adventures of this band has been given elsewhere,² and it will suffice here to give their itinerary as briefly as may be.

From Knoxville, Tenn, the rendezvous, travel was by wagon through Chilhowee Gap to Cade's Cove,³ in Blount county, Tenn., a valley adjacent to the main range of the Great Smokies. Thence with guides, pack mules and camping outfit we ascended Thunderhead, camping at "Spencer's Cabin," and collecting both near the summit and at various lower levels. Ferriss made a day's journey to Block House Mountain, a peak running up to some 5,500 feet, nameless on the Geological Survey topographic

¹ All of those mentioned have contributed valuable notes and specimens toward this paper, so that it really represents our joint and several observations, which I have correlated and systematized. To this end, most of the smaller or more critical specimens have been generously entrusted to me for examination, to the number of some six or eight thousand shells including those collected by myself.

It should be mentioned that Mr. Ferriss had previously made several vacation journeys to the Great Smokies, and Mr. Clapp was there in 1898. The richness of the region in molluscan life was first made known by Mrs. George Andrews, of Knoxville, although Rugel, many years ago, evidently ventured within the mountain fastnesses, and Miss Law visited the outlying ridges.

² *Nautilus*, 1900.

³ A mountain valley becomes a "cove" on the tongue of the mountaineer. Some of the "coves" are of considerable extent and nearly level; the soil is fertile and the farms productive and beautiful. Cade's Cove is also the name of a post-office in the valley. The localities "Sugar Cove," "Rose Cove," Brannon's, Rowan's, "Laurel Creek" are all in Cade's Cove or subsidiary valleys thereto. During our stay in Cade's Cove we were indebted to Mr. Blair for numerous courtesies, which are here gratefully acknowledged.

map, but shown on the Knoxville sheet, due south of Thunderhead, with which the 4,700 foot contour connects it. From Thunderhead the trail follows the ridge along the Tennessee-North Carolina boundary, over Briar Knob (an outrageous climb) and Proctor's Knob to the south end of Miry Ridge. Thence over Siler's Bald to Clingman Dome (6,600 feet altitude), still upon the interstate boundary. The main collecting ground on Clingman was a few hundred feet below the summit along the north side. This was the last camp of Messrs. Clapp, Walker and myself; but Mr. Ferriss and Mr. Sargent explored beyond, first visiting Andrews Bald, an outlier of the Clingman mass, and then returning to Siler's Bald they followed the crest of the great ridge ramifying southwest, to Welch Bald, which reaches 5,000 feet elevation. From this peak they descended the Welch Bald Branch to Chamber's creek, and down to the Little Tennessee river. Crossing the river into Graham county, N. C., they ascended Tuskegee creek, collecting *en route* and on "Tuskegee Mountain" (not named on the Nantahala topographic sheet), a spur of the Cheoah Mountains which projects northward between the headwaters of Tuskegee creek and Yellow creek. Most of the shells here came from a valley called "Ramp Cove," on the Yellow creek side. Along Yellow creek they followed the road to the Cheoah river. From here they entered the Unaka Mountains,⁴ ascending the twin peaks Hangover and Mt. Hayo (5,200 feet) and Stratton Bald, (5,400 feet)—this peak named for Robert Stratton, being locally known as "Bob's Bald." Some collecting was then done in "Glen Cove," nameless on the Geological Survey map, but readily located as one of the heads of Slick Rock creek, in Tennessee. They then turned northward in Monroe county, Tenn., stopping at Tallassee ford of the Little Tennessee river, at Caringer, Tenn., where they collected on the south side of the river, finally returning across country to Cade's Cove.⁵ Mr. Sargent made a journey by rail to Hayesville, Clay county, N. C.,

⁴ This Unaka range must not be confused with another so-called on some maps, lying to the west of Roan Mountain.

⁵ No ordinary atlas gives an adequate idea of the extent or complexity of this mountain region. Recourse must be had to the excellent topographic maps published by the U. S. Geological Survey. The localities mentioned on the route described above will be found on the Knoxville, Mt. Guyot, Nantahala, Murphy and Loudon sheets.

the malacological results of which have been incorporated in this list.⁶

In the region where collecting was done the country rock is mainly sandstone and a coarse gray conglomerate. The coves are said to have a floor of limestone, but it is evidently buried deeply, as I noticed no exposures. There is a good exposure of the "Hazel Slate" on the dizzy, knifelike ridge connecting Siler's Bald and Clingman Dome. The strata along the boundary ridge dip deeply to the south and southeast, and the débris of the broken edges falling down the northern and northwestern declivities makes more abundant shelter for rock-loving snails on this than on any other slope. Springs can be found almost anywhere, up nearly to the mountain tops, and frequent rains or cloud-mist hanging about the summits keep the ground moist, and the deep moss holds water like a sponge.

RELATIONSHIPS OF THE GREAT SMOKY MOUNTAIN FAUNA.

The Appalachian mountain system is divided in the south by the broad valley of eastern Tennessee into two divisions unlike in their physical features and geological structure. The level strata of the Western Division, or Cumberland Plateau, though more or less dissected by stream-erosion, never become so rugged as the steeply tilted strata forming the noble mountains of the Eastern Division.

Faunally the two divisions have hitherto been considered to constitute a zoögeographic unit, under the title of the "Cumberland Subregion."⁷ The inclusion of both the Eastern and Western Divisions under one zoögeographic term would lead one to suppose a numerically important part of the characteristic species composing the fauna to be common to the whole tract; but the collector on the ground finds this to be far from the truth. A certain number of land snails extend over the whole mountain region and far east and west of it; but of those restricted to the Appalachian system we find that the Cumberland Plateau has its own set of species, and the eastern mountains another. The characteristic

⁶ It may be mentioned here that the shells Ferriss collected in 1898 and labeled "Unaka Mts." were taken on Citico Creek, in Monroe county, Tenn.

⁷ See W. G. Binney, *Manual American Land Shells*, p. 33.

species, those which give the mountain regions individuality as contrasted with the lowlands, are very largely different on the two sides of the great valley.

I would submit, then, that the "Cumberland Subregion" as understood hitherto is not a faunal unit, but contains two faunulæ as diverse from one another as either is from the lowland fauna to the west or the east of the mountains.

Characteristic forms illustrating this diversity are as follows:

EASTERN DIVISION.	WESTERN DIVISION.
(Roan Mt. to the Great Smokies.)	(Cumberland Plateau.)
<i>Polygyra chilhoweensis</i> ,	<i>Polygyra plicata</i> ,
" <i>subpalliata</i> ,	" <i>dorfeuilliana</i> ,
" <i>ferrissii</i> ,	" <i>fatigiata</i> ,
" <i>clarkii</i> ,	" <i>troostiana</i> ,
" <i>andrewsæ</i> ,	" <i>tridentata complanata</i> ,
" <i>wheatleyi</i> ,	" <i>wetherbyi</i> ,
" <i>christyi</i> ,	" <i>obstricta</i> ,
" <i>lawæ</i> ,	" <i>sargentiana</i> ,
" <i>depilata</i> ,	" <i>downieana</i> ,
" <i>barbigera</i> ,	" <i>spinosa</i> ,
" <i>hirsuta altispira</i> ,	" <i>labrosa</i> ,
" " <i>pilula</i> ,	" <i>edgariana</i> ,
" <i>maxillata</i> .	" <i>edwardsi</i> ,
	" <i>stenotrema exodon</i> .
<i>Omphalina rugeli</i> ,	<i>Omphalina inornata</i> .
" <i>subplana</i> ,	
" <i>andrewsæ</i> .	
<i>Vitrinizonites</i> .	
<i>Zonitoides patuloides</i> .	<i>Zonitoides lateumbilicatus</i> .
<i>Gastrodonta lasmodon</i> ,	<i>Gastrodonta collisella</i> .
" <i>cœlaxis</i> ,	
" <i>andrewsæ</i> ,	
" <i>clappi</i> ,	
" <i>walkeri</i> .	
<i>Pyramidula alternata costata</i> ,	<i>Pyramidula alternata carinata</i> ,
" <i>bryanti</i> .	" <i>cumberlandiana</i> .

The list could be increased, but these main genera sufficiently illustrate the distinctness of the faunas. It seems that the depres-

sion of the East Tennessee valley practically prevents intermingling of the mountain species, and has doubtless been a barrier far back into Tertiary time. Further north, in the Virginias and Pennsylvania, the distinction is almost obliterated; partly owing to the absence of an intervening tract so markedly differentiated physically, and partly because, if the northward extensions of the eastern and western divisions of the mountain system ever had special faunas, they were obliterated by the severe conditions of the Ice Age far beyond the southern border of the actual ice sheet, and there has not been time for the differentiation of new faunas in the North.

The Eastern Division, with which we have particularly to do, extending in a great ridge from northeast to southwest, between Tennessee and North Carolina, is cut transversely into several sections by rivers breaking through the highest ranges—the upper Nolichucky, the French Broad and Little Pigeon, and the Little Tennessee. The mollusk fauna of the section above the Nolichucky is fairly well known by the researches of many naturalists on Roan Mountain and in its vicinity, Mrs. George Andrews and Mr. A. G. Wetherby having contributed most largely to our knowledge.

The Great Smokies proper, as far east as Clingman, and the mountains along the southern side of the Little Tennessee, are now fairly known by the work of Mrs. Andrews and our party of five, and especially by Ferriss' explorations, though no doubt the lists of species will be largely augmented in future.

The mountain region between the Nolichucky and Clingman's Dome, a distance of about seventy-five miles as the crow flies, is *wholly unknown malacologically*, so far as I know. We may reasonably expect the forms common to Roan and the Great Smokies to occur in this intermediate tract; but in view of the extreme local differentiation, specific and varietal, in the known areas, how many splendid snails, never yet seen by man, still lurk in their rocky shelters along these mountain tops!

Comparing the fauna of Roan Mt.⁸ and its environs with that of

⁸ For the fauna of Roan I take Wetherby's papers: "Some Notes on American Land Shells," *Journ. Cincinnati Soc. N. H.*, IV, 1881; and "Natural History Notes from North Carolina," in the same *Journal*, XVI, 1893, p. 87, and XVII, 1894, pp. 69 and 209. These articles, containing the observations of an experienced naturalist, give as good an idea of the fauna as could be obtained without actually working over the ground.

the Great Smokies below Clingman shows the following forms common to the two tracts, exclusive of those occurring also in the Cumberland Mts. or elsewhere:

<i>Polygyra andrewsæ</i> ,	<i>Vitrea sculptilis</i> ,
“ <i>wheatleyi</i> ,	<i>Zonitoides elliotti</i> .
<i>Vitrinizonites latissimus</i> ,	<i>Philomycus wetherbyi</i> .
<i>Omphalina subplana</i> ,	

Special to the Roan Mountain neighborhood are:

<i>Polygyra subpalliata</i> ,	<i>Gastrodonta andrewsæ</i> ,
“ <i>hirsuta altispira</i> ,	“ <i>cœlaxis</i> ,
<i>Omphalina rugeli</i> ,	<i>Pyramidula bryanti</i> .

And the following forms have hitherto been found only in the Great Smokies and adjacent ranges along the Little Tennessee river:

<i>Polygyra chilhoweensis</i> ,	<i>Zonitoides patuloides</i> ,
“ <i>ferrissii</i> ,	<i>Pyramidula alternata costata</i> ,
“ <i>depilata</i> ,	<i>Punctum blandianum</i> ,
“ <i>edwardsi magnifumosa</i> ,	<i>Gastrodonta lamellidens</i> ,
“ <i>hirsuta pilula</i> ,	“ <i>walkeri</i> ,
<i>Omphalina andrewsæ</i> ,	“ <i>clappi</i> .

And also some varietal forms of various other species.

VERTICAL DISTRIBUTION OF SPECIES.

Our data on *Polygyra andrewsæ* show that mere altitude has little, if any, influence within the limits afforded by the region investigated. Thus, on the flanks of Thunderhead Mt., the shells up to fully 4,000 feet do not differ in size or other characters from those of Cade's Cove, at half that elevation. At Proctor's Knob (5,000 feet) and Miry Ridge (4,500–5,000 feet) the average size and solidity of the shells is undoubtedly somewhat greater than at the lower stations, though the conditions do not differ much, and the country rock is not greatly different. What favorable local cause works this change is not clear. It is only near and at the exposed mountain tops themselves that the shells suddenly diminish in size and solidity, as among the scrubby beeches at the storm-swept summit of Thunderhead, or along the lofty ridge of Clingman, from 5,500 to 6,500 feet elevation.

Polygyra wheatleyi, also a species of wide distribution, is similar

to *P. andrewsæ* in its variations. The toothed form with wide lip occurs throughout the region, except along the ridge of Clingman, where a more delicate and toothless form replaces the ordinary one. For the rest it varies greatly in size, and without reference, so far as I can see, to altitude or exposure, the other factors of soil and vegetation being probably more potent. Extremely small specimens occurred in the Tuskegee Mountains (between Yellow creek and Tuskegee creek), at a small elevation, and very large ones on Stratton Bald, over 5,000 feet above the sea. The only locality in which anything like racial characters are appearing, however, is on Clingman, as mentioned above, the only locality, so far as I know, where the forest is coniferous.

Polygyra ferrissii has been found so far only at elevations above 4,000 feet, on the Clingman conglomerate which crowns Miry Ridge and Clingman's Dome, though probably some of the lower stations are on the Thunderhead conglomerate, lithologically the same. An equilateral triangle with sides about seven miles long, the angles at Miry Ridge, Andrews Bald and Welch Bald, includes all known localities, though it certainly does not occur over much of the small area thus enclosed. The researches of our party along the high ridge west from Miry Ridge, and Ferriss' and Sargent's search to the south, make it probable that the species has no great extension in these directions. It remains to be seen whether it extends along the interstate boundary ridge toward Mt. Guyot and the Big Pigeon river gap, but such extension is likely.

Polygyra depilata has occurred so far only along the interstate boundary ridge from Thunderhead to Clingman's Dome, reappearing south of the Little Tennessee river on Stratton Bald.

Pyramidula alternata costata has been found only along the south side of Cade's Cove. The small Gastrodonts are probably more widely distributed than existing data indicate.

LIST OF SPECIES.

HELICINIDÆ.

Helicina occulta (Say).

Rowan creek, Cade's Cove. A single, rather thick-lipped small specimen, diam. $5\frac{1}{2}$ mm., was taken by Ferriss, and two more by Sargent. This is further south than any previous record.

HELICIDÆ.

Polygyra tridentata (Say).

Practically typical specimens of this species occur in the upper Tennessee Valley in eastern Tennessee. In the Great Smokies, however, a divergence occurs which I have not seen from any other locality. The basal tooth is split into two denticles; either distinctly or obsoletely; or without being bifid, the tooth has a callous slope or buttress against its outer side. This tendency to double the basal tooth evidently characterizes a mountain race, but I doubt whether the race be yet firmly enough established to require recognition in nomenclature. The localities are: "Roe's Flat," in Cade's Cove (Ferriss and Clapp, 1898), diam. 16 to 18 mm. Brannon's, Sugar Cove, off Cade's Cove, one specimen; basal tooth very heavy. Hannah Mt. (Ferriss, 1898). Welch Bald, on the Forney Ridge, diam. ranging from slightly over 13 to nearly 18 mm.; basal tooth nearly as simple in a few specimens as in *tridentata*, distinctly double or buttressed in others. Ten specimens collected by Ferriss. A single *P. fraudulenta* with typical aperture was taken with them. *P. tridentata* also was taken on Welch Bald branch of Chamber's creek, and on Chamber's creek down to the Little Tennessee.

South of the Little Tennessee, in Graham county, Ferriss took specimens on Yellow creek and Bob's Bald; in both localities the basal tooth was double or calloused.

"Other characters of the mountain form of *P. tridentata* are the tubercular upper tooth and the flattening of the basal lip. Another variety of *tridentata* from Oakdale, Morgan county (Clapp, 1899), and Concord, Knox county (in the James H. Lewis collection), has the aperture of var. *complanata*, with very small and widely spaced teeth, but is striated like typical *tridentata*. Largest from Concord, diam. 23 mm., alt. $10\frac{1}{2}$ mm.; smallest, diam. $19\frac{1}{2}$, alt. 9 mm. Largest from Oakdale, diam. $20\frac{1}{4}$, alt. $9\frac{1}{2}$ mm.; smallest, diam. 19, alt. 10 mm."—*G. H. C.*

Polygyra fraudulenta Pilsbry..

Welch Bald, Swain county, N.C. One specimen, diam. 13 mm.

Polygyra rugeli (Shuttl.).

An abundant species. Tuckaleechee Cove, at about 1,200 feet elevation, two rather small shells, 11 mm. diam. Cade's Cove, very abundant, usually about 14 mm. diam., the ordinary variation 12 to 15. One umbilicated specimen taken, and one slightly

less than 9 mm. diam., the smallest *rugeli* on record. Ferriss took a specimen in 1898 which is distinctly carinated at the periphery, this being from "Roe's Cove."

Of ten specimens collected at Brannon's, Sugar Cove, off Cade's Cove, by Ferriss, five measure 9 to 10 mm., one $10\frac{1}{2}$, and four $13\frac{1}{2}$ to 14 mm. Some of these are among the smallest specimens of the species seen.

On Thunderhead, in the Eagle creek region, N. C., probably between 3,500 and 4,500 feet, the extremes in a series collected are 11 and 15 mm. diam.

"Quite common on Miry Ridge in 1898, probably about 4,000 feet, about same size as Cade's Cove specimens, average. The smallest shell of this species which I have seen is from Russellville, Ala. (Lewis collection), $8\frac{1}{2}$ mm. diam. From Scott county, Va., I have two specimens of 9 and $9\frac{1}{2}$ mm. diam. respectively."—*G. H. C.*

It occurred also on Andrews Bald, Welch Bald and Chamber's creek.

On the Little Tennessee river, at mouth of Chamber's creek, Mr. Ferriss collected small specimens, 11 to 12 mm. South of the Little Tennessee river specimens were taken on Cheoah creek, and in Glen Cove, in the Unakas, twenty-one specimens, varying gradually from $10\frac{1}{2}$ to $14\frac{1}{2}$ mm. diam.

At Tallassee ford, Little Tennessee river, in Monroe county, Tenn., a dozen specimens taken by Ferriss vary from 12 to nearly 13 mm., being thus very uniform in size.

***Polygyra chilhoweensis* (Lewis).**

This magnificent species is characteristic of the Great Smoky Mountains, having been described from an outlying ridge, the Chilhowee Mountain, which rises some 2,000 to 2,500 feet—about the elevation of the slopes of Cade's Cove. In large series collected by the party of 1899, and in those taken by Ferriss and Clapp in 1898, no intergradation with *P. sayii* Binn. was observed. *P. chilhoweensis* is always larger, with broader lip and more obsolete teeth or none. *P. sayii* is not known to occur in the region, though Wetherby has taken it at Roan Mountain.

Of many specimens taken by our party, 1899, in "Sugar Cove," off Cade's, the largest I have seen measures 39 mm. diam., the smallest 31 mm. Mr. Ferriss gives 40 and $27\frac{1}{2}$ mm. as the diameters of his largest and smallest specimens.

At Eagle creek, N. C., on Thunderhead, 35 mm. diam.

Proctor's Knob (on the Tennessee-North Carolina boundary, between the south end of Miry Ridge and Briar Knob), 33 mm. diam.

South end of Miry Ridge, 31-34 mm. Ferriss' 27½ mm. shell was from Miry Ridge.

On Clingman's Dome it is rare, occurring on the western end, probably at about 4,800 feet. We did not find it near the summit.

South of the Little Tennessee Ferriss found it on Yellow creek, Graham county, N. C., and in Glen Cove, one of the heads of Slick Rock creek, in the Unaka Mountains.⁹

⁹ Mr. Clapp furnishes the following table of measurements of specimens of *P. sayii* and *P. chilhoweensis* in his collection :

Polygyra sayii Binn.

Gr. diam.	17½	lesser	15	alt.	10½	mm.	New York.
"	19	"	17½	"	11¼	"	North Carolina.
"	20	"	17	"	13	"	New York.
"	20½	"	18	"	11	"	North Carolina.
"	20½	"	17½	"	11½	"	"
"	21½	"	19	"	13	"	New York.
"	23	"	20	"	13½	"	Ontario, Can.
"	23	"	19	"	13	"	Pennsylvania.
"	23	"	20	"	13	"	Ohio.
"	24½	"	21½	"	15	"	West Virginia.
"	25½	"	22	"	14	"	Virginia. This specimen has a double parietal tooth.
"	27½	"	24	"	16	"	Kentucky.
"	28	"	24	"	16	"	Virginia.
"	28½	"	24½	"	17	"	"

Polygyra chilhoweensis Lewis.

Gr. diam.	31½	lesser	26½	alt.	21	mm.	Miry Ridge. Tenn.
"	31½	"	27	"	20	"	" The Balsams."
"	33	"	28½	"	18½	"	Braden Mt., Campbell county.
"	33	"	28	"	21½	"	Miry.
"	35	"	30	"	21	"	Toothed. Campbell county.
"	35½	"	30	"	22	"	" Cade's.
"	36¼	"	31	"	20	"	" "
"	36½	"	31	"	21	"	Cade's.
"	36½	"	32	"	24½	"	Unaka Mountains.
"	37½	"	32	"	22½	"	Campbell county.
"	38	"	33	"	24½	"	Toothed. Cade's.
"	39	"	33	"	24½	"	" Miry.
"	39¼	"	33	"	24½	"	Unaka Mountains.
"	42	"	35½	"	26½	"	Bald Mountain, 6,000 feet, Blount county, Tenn.

This last giant is in the Lewis collection, and Dr. Lewis says: "Cubic dimensions 9.65 of *H. diodonta* of the size of Say's type." I think the altitude given for Bald Mountain, 6,000 feet, is a mistake.—*G. H. C.*

***Polygyra albolabris* (Say).**

Cade's Cove, at "Roe's Flat" and "Laurel Creek" (Ferriss and Clapp), Blount county, Tenn. South of the Little Tennessee, in Graham county, N. C., Ferriss reports the species from Tuskegee Mountain (at the head of Yellow creek), Yellow creek, and the Cheoah river.

We did not find *albolabris* on the mountains and it probably does not ascend over 2,500 feet, if so high as that, in this region, being confined to the coves.

The specimens from Cade's Cove are heavy, solid shells, 32 to 35 mm. diam., of beautiful texture, the microscopic sculpture being sharply developed. Many of them blush with a distinct rose tint above, the base pale yellow. The white peristome is strongly developed.

I have been disposed to refer these shells to the variety *major*, the typical form of which occurs in Georgia and western extrapeninsular Florida; but the dividing line between *albolabris* and *major* is at best an exceedingly indistinct one, and we may perhaps be nearer the truth if we consider the shells of this region as a transition between *albolabris* and *major*. A specimen from Johnson City, in the valley of East Tennessee, measures 38 mm. diam.

***Polygyra exoleta* (Binn.).**

Cade's Cove, abundant; Glen Cove, Unaka Mountains, N. C.; Tallassee ford, Caringer, Tenn.; well-developed shells of the normal form. It was not found by us on the mountains, but in the coves, and apparently does not ascend much above 2,000 feet. "The Cade's Cove shells vary in color, some having a very dark spire shading to nearly white on the base, while others are either uniform dark or light."—G. H. C.

***Polygyra ferrissii* Pils.**

This beautiful species can never become common, so rugged and remote are its mountain haunts. To the north and northwest of the summit of Clingman's Dome the slope is steep, frequently precipitous, and covered with a talus of great blocks of rock, deeply carpeted with sphagnum and shaded by great balsam firs.¹⁰ Like the other mountains of this ridge, Clingman seems to be a mono-

¹⁰ Besides the balsam fir or "she balsam," *Abies fraseri*, the *Picea rubens* Sargent is mingled with it in the Clingman forest. I am indebted to Mr. Thomas Meehan for the identifications, based on cones and foliage.

cline, the massive conglomerate beds dipping steeply to the south or southeast. This results in a rocky talus on the north or north-west slopes, from disintegration of the faulted or eroded edges of the strata, while the other slope is less rugged. Mossy trunks lie in every direction, making progress slow and difficult.

It is on the wet and bare under surfaces of blocks resting free from the ground that Ferriss' *Mesodon* lives. Kneeling or lying at length on the wet moss, and peering or crawling into these black crevices, we found the snails on the rock roofs of the cavities, but only in small numbers. Candles were occasionally of use.

A few specimens were taken among the rank herbage covering the ground near the summit of the ridge, where they live with Clapp's variety of *Polygyra andrewsæ*.

Besides this locality near the summit of Clingman, a few specimens were taken from a similar station about one and a half miles down the west end of the mountain on the Tennessee side, probably near the 4,000 foot contour. This spot was reached by a desperate climb in the bed of a leaping brook, through a dense laurel thicket, the way led by the indomitable Ferriss. This locality is a jolly good place for hard work, but a poor one for snails.

Ferriss and Sargent found *P. ferrissii* on Andrews Bald, which is really but a spur of the Clingman mass.

Another spot at which *P. ferrissii* has been taken is on "Miry Ridge on the western slope, from a quarter to a half mile below the point where the ridge leaves the boundary range. The situation is very similar to that described above for Clingman, except that many of the fallen stones are smaller and the bulk of the collecting was done by 'quarrying.' On the southern side of the main range Ferriss found a few specimens in 1898. These two localities are so close together that they may be considered as practically the same."—G. H. C.

Along the great ridge ramifying southward from Siler's Bald, Ferriss and Sargent found *P. ferrissii* at Welch Bald. This peak rises to 5,000 feet, and is connected with Miry Ridge and Clingman by the 4,000 foot contour.

P. ferrissii does not show much variation so far as known. Ferriss found a single albino, a lovely light-green shell, which he gave to the Academy, and Sargent found two light-colored shells, one

of which was albino, in 1899. Of the specimens taken on Clingman, the largest measures $23\frac{1}{2}$, the smallest 19 mm. diam.

***Polygyra palliata* Say.**

Taken by Ferriss at Laurel creek, Cade's Cove. It is apparently wanting in the mountains along the interstate boundary, but reappeared in the Little Tennessee region on Chamber's creek, and at its mouth, on Bob's Bald (Stratton Bald), at Glen Cove, Unakas, and Tallassee ford, Monroe county, Tenn. Mr. Clapp observes that the southern specimens are less hairy than the northern.

***Polygyra appressa perigrapta* Pils.**

Tuckaleechee Cove; Cade's Cove; Eagle Creek, Thunderhead, about 4,000 feet; Block House, "The Balsams," west end of Clingman, about 6,000 feet; Welch Bald creek and Chamber's creek, to the Little Tennessee. Everywhere well-developed, typical specimens. South of the Little Tennessee, Ferriss took specimens on Tuskegee creek, Cheoah creek, Bob's Bald and in Glen Cove. We found *P. appressa sculptior* Chadw. on the bluffs of the Tennessee, opposite Knoxville.

***Polygyra clarkii* (Lea).**

Cade's Cove. Fine specimens were taken about 1,000 feet below the summit of Thunderhead, on the North Carolina side, though it is far from common. The largest and smallest shells measure: Alt. $10\frac{1}{2}$, diam. 14 mm.; alt. 10, diam. $13\frac{1}{2}$ mm. Clingman's Dome and Andrews Bald; Welch Bald branch of Chamber's creek; and south of the Little Tennessee on Tuskegee and Cheoah creeks, in Glen Cove, and at Tallassee ford of the Little Tennessee.

"Ferriss and I found this species on Miry Ridge in 1898, at about 4,000 to 4,500 feet. *Decidedly scarce*. Largest alt. 12, diam. $15\frac{3}{4}$ mm. Largest from Thunderhead, just below Spencer's Cabin, alt. $10\frac{1}{2}$, diam. $15\frac{1}{2}$ mm. Largest from Cade's Cove, alt. 11, diam. 15 mm."—G. H. C.

***Polygyra thyroides* (Say).**

We did not find this species along the Tennessee-North Carolina boundary, but Ferriss found it in North Carolina, at Welch Bald, and on the Little Tennessee at mouth of Chamber's creek, and at Tallassee Ford. I picked up a specimen at Porter's Academy, Blount county, Tennessee.

Polygyra andrewsæ (W. G. Binney).

This species was originally described from the thin, small, greenish horn-colored form occurring on the upper 2,000 feet of Roan Mountain. This form is in reality a local race of a species widely spread along the mountain ridge between Tennessee and North Carolina, and eastward, probably throughout the mountains, extending into Georgia. Just what its westward limit may be is uncertain; but apparently it does not invade the valley of eastern Tennessee watered by the Holston, Nolichucky and Tennessee rivers. In Blount county, Tenn., we did not find it below about 2,000 feet, first encountering the species on the slopes of Cade's Cove. Whether it occurs at lower levels, or in the isolated Chilhowee ridge, remains to be seen, as no exploration has been made. It is obviously not a species of the Cumberland elevation, in the proper restriction of that term.

Typical *P. andrewsæ* will, of course, be restricted to the small Roan Mountain race, first described and well represented by Mr. Binney's figures (*Man. Amer. Land Shells*, fig. 321). For the larger, more solid, yellowish-brown or slightly greenish form, with wider lip and a more or less distinct prominence (hardly a tooth) on the columella, the varietal name *normalis* may be used, the types being from Cade's Cove, Blount county, Tenn.

The typical *P. andrewsæ* is not known to occur in the Great Smoky Mountains.

P. andrewsæ normalis n. var.

This is the form occurring throughout the Great Smokies, in the coves and on the mountain sides, up in some places to 4,500 feet, as at the southern end of Miry Ridge, or even higher, at the western end of Clingman's Dome. Specimens with a parietal tooth are very rare, and have only a small or indistinct tooth. No example of var. *normalis* with a band is known. Our collecting gave the following data:

Cade's Cove. The snails live on densely wooded mountain sides in the subordinate coves on the Thunderhead side at an elevation of about 2,000–2,500 feet. We found them crawling on the ground, and especially on logs or sticks. The lip is broad; none show a parietal tooth, and none are banded or dark colored. Largest of a series of seventy-five, $34\frac{1}{2}$ mm. diam.; smallest, 29

mm.; average of the entire lot $31\frac{1}{2}$ mm. Seventy-five per cent. of the shells measure 31–33 mm. diam.

Eagle creek, on the South Carolina side of Thunderhead, from about 3,500 to 4,000 feet. Station similar to Cade's Cove, but sometimes crawling up trees four to six feet. The shells are similar to the preceding lot, but there are apparently more very pale or albino specimens among them. Largest of a series of nineteen, $33\frac{1}{2}$ mm. diam.; smallest, 29 mm.; average of the lot, 31 mm. diam. Two-thirds of the shells are 31–32 mm. diam.

Proctor's Knob, on the Tennessee-North Carolina boundary, west of Miry Ridge; alt. about 5,000 feet. The shells taken are solid and large, measuring 32, 33, 33, 34, 35 mm., diam.; average $33\frac{1}{2}$ mm.

South end of Miry Ridge, 4,500–5,000 feet altitude, on the boundary trail. Sixteen specimens, two with a very slight trace of a parietal tooth. A few show a slight channel at the upper termination of the outer lip. They occurred on logs of a former camp. Largest specimens, 33 mm. diam.; smallest, 30 mm.; average of the lot, 32 mm. diam. The shells are more solid than at Eagle creek or Cade's Cove.

“Miry Ridge, in Tennessee. In 1898 Ferriss and I followed out the ridge a few hundred yards and then down the western angle probably 2,000 feet. (According to the ‘Knoxville sheet’ Miry is 5,000 feet high where it leaves the boundary.) We collected *normalis* all the way down, but found it most plentiful on top. It was a very wet season and the snails were all over the ground and weeds and even on the trees several feet above the ground. My largest from Miry is $36\frac{1}{2}$ mm. diam.; smallest, $31\frac{1}{2}$ mm. diam. Many of the shells were very globose, two measuring, alt. $27\frac{1}{2}$, diam. 32 mm., and alt. 28, diam. $34\frac{1}{2}$ mm., respectively. One shell, 33 mm. diam., has a strong parietal tooth, and two others have faint teeth.”—G. H. C.

Western end of Clingman's Dome, at about 5,600–5,800 feet. Specimens of the large variety (*normalis*) are rare here, only two being found by me, to nineteen of the small variety (see below), during a long search. These measure 32 and 33 mm., are rather solid, toothless, without a groove at the upper insertion of the lip, and quite similar to specimens from Miry Ridge. Clapp writes of the specimens from this locality: “Shells from

'The Balsams' are large and very heavy, largest $35\frac{1}{2}$ mm., smallest 30 mm. diam." As at the second Miry Ridge locality, it occurs here with the var. *altivaga*, but only sparingly.

It was taken also at Andrews Bald and on Chamber's creek by Ferriss. South of the Little Tennessee, Ferriss took specimens on Tuskegee creek and Yellow creek, Cheoah river and in Glen Cove, one of the heads of Slick Rock creek. In the Unaka Mountains, not far from Citico creek, the shells are large and solid, toothless or with the slight trace of a parietal tooth, lip not grooved at its junction above. Diam. $33-36\frac{1}{2}$ mm. A series would probably show them to be perceptibly larger as well as more solid than the Miry Ridge shells, which excel those of other localities mentioned above.

P. andrewsæ altivaga n. var.

This is the form of the higher mountain tops. It is characterized by the small size, globose contour, compact coiling of the whorls which scarcely exceed five in number; the striation being very fine and delicate; parietal wall unarmed or with a small acute tooth; lip flat and rather wide, the internal rib interrupted near the upper termination, leaving a slight channel at the angle of junction, more or less obvious in different specimens. Shell thinner in adults than in adults of var. *normalis*; colors typically darker and richer, but varying to pale with a dark band above the periphery. Types from near the summit of Clingman's Dome, with *P. ferrissii*.

Mr. Clapp first directed attention to this form, which he and Mr. Ferriss took at the summit of Thunderhead and at Miry Ridge in 1898. While there is no sharply defined single character separating it from the ordinary form of *P. andrewsæ normalis*, yet among some hundreds of specimens of *P. andrewsæ* I have examined I find it easy to distinguish this form, which is by all odds the handsomest of the varieties of *P. andrewsæ*. The following details relate to special localities:

Clingman Dome, near the summit, 6,500 feet elevation. On herbage and moss on the ground, shaded by balsams. The shells are often dented while alive, and mostly appear to complete their growth in two seasons, the second period of growth beginning of a lighter color and slightly coarser texture than the preceding growth. Of thirty-two specimens the largest has a diameter of

28, the smallest 24 mm., eighty per cent. being from 25 to 27 mm., the average of the lot is 26 mm. Thirty per cent. are more or less distinctly banded. Mr. Clapp writes of the specimens taken by him that "out of thirty-six shells, nineteen are dark and seventeen banded, some of the latter with only the peripheral band, others with an additional subsutural band. Largest 29 mm., smallest $24\frac{1}{2}$ mm. diam. West of 'Double Springs' I got one specimen $31\frac{1}{2}$ mm. diam., alt. 24 mm."

Andrews Bald, south of Clingman Dome, and connected with it by a high ridge, alt. about 5,800 feet. Forms entirely like that on Clingman were found here by Ferriss.

West end of Clingman, between 5,500 and 6,000 feet. Shells similar to those from top of Clingman, but usually paler colored. Fewer specimens are banded, one with two distinct bands; and a few specimens show a minute but sharply defined parietal tooth, quite near the upper end of the lip. The largest of nineteen examples is 28 mm., the smallest $24\frac{1}{2}$ mm. diam.; average of the lot 26 mm.

Miry Ridge. "In the same locality as *ferrissii*, and either under the rocks or in the moss overhanging the edges of the rocks, on the western angle of the ridge. I think the Miry Ridge shells collected last year are more typical than those from Clingman as they are more mature and heavier. Out of fifteen Miry Ridge specimens in my collection, six have the parietal tooth strong, three have it faint and six are toothless. These shells also show the channel much better than those from Clingman on account of the lip being fully formed. Of the fifteen shells, three are dark, six are light (we did not get this color variety on Clingman), two have a peripheral band, one has a faint line between the band and the suture, and three are what Ferriss calls 'half and half'—that is, the band extends from the periphery to the suture. Largest Miry shell diam. 30, alt. $21\frac{1}{2}$ mm.; smallest, diam. 26, alt. $18\frac{1}{2}$ mm."—G. H. C.

The specimens vary from the pale greenish-yellow tint, occasionally with a band above, to a dark reddish-brown color, similar to the Clingman form. The largest of twelve specimens is $28\frac{1}{2}$, the smallest 25 mm. diam.; average of the lot 27 mm. diam.

Thunderhead, at the summit, in a sparse growth of scrub beeches, under bunches of moss on the trunks. The shells are

pale green or tinted with red, frequently with a reddish band, and sometimes having an indistinct band at the suture. The largest of six shells measures $25\frac{1}{2}$ mm., the smallest $22\frac{1}{2}$ mm.; average of the lot 24 mm. Mr. Clapp found nine shells, which measure, "Largest 26 mm., smallest 23 mm.; average of lot $24\frac{1}{2}$ mm. One is dark red, four light, three with a single band, and one dark above, lighter beneath. One has a faint parietal tooth."

The shells inhabit a grove of beeches at the edge of the "bald." The trees are dwarfed by the exposed situation, and look, as one approaches the grove, like an old country orchard. The shells differ from those of Clingman in being smaller on the average and paler colored. The form is that of the Clingman *altivaga*.

Polygyra wheatleyi (Bld.).

A characteristic and widespread species in this region. It is allied to *P. ferrissii* rather than to the species with which it has hitherto been grouped. The specimens vary considerably in size, and in presence or absence of the parietal tooth, the variations being mainly local rather than indiscriminate.

Specimens from Cade's Cove (2,000 feet) and Thunderhead (up to 5,300 feet) are of good size, 13 to $16\frac{1}{2}$ (rarely 18) mm. diam., moderately solid, with very broad lip and a well-developed parietal tooth when mature. Similar specimens occur on Block House Mountain (south of Thunderhead), diam. 16 to 17 mm.

Ferriss found some beautiful greenish-white albino specimens in Cade's Cove.

Miry Ridge. "Quite common in 1898, and intermediate between the Thunderhead and Clingman forms, the lip being narrow and the parietal tooth small. Smallest of five, 14 mm.; largest, $15\frac{1}{4}$ mm. diam. Found down the western slope, from 4,000 to 4,500 feet."—G. H. C.

On Clingman Dome the shells are all small, diam. $12\frac{1}{2}$ to 14 mm., thin, *without a parietal tooth*, the aperture more rounded, and the lip less flattened. This seems quite a well-marked local form. It occurred from our camp near the western end to the summit.

On Welch Bald the shells are like those from Cade's, diam. $14\frac{1}{2}$ –16 mm. Ferriss took it also along Chamber's creek.

South of the Little Tennessee, specimens were taken by Ferriss

on Tuskegee Mountain (north of Tuskegee creek), where they are remarkably small, diam. 12-12½ mm., but the lip is wide and a parietal tooth developed in fully adult shells. They are not like the form from Clingman. At Bob's Bald, near Mt. Hayo, in Graham county, N. C., the shells are very large, 20-23 mm. diam., the parietal tooth present but small. On Hangover Lead, four miles east of Mt. Hayo, they are 12½-13 mm., and all dentate. Mt. Hayo, 16-17 mm., dentate. At Tallassee ford of the Little Tennessee river, the specimens are like those from Cade's Cove. It occurs also in Glen Cove.

Polygyra christyi (Bld.).

Roes Cove and Rowan's in Cade's; one specimen taken on Clingman's Dome. South of the Little Tennessee, Ferriss and Sargent found it on Tuskegee creek and Cheoah river.

Subgenus **STENOTREMA.**

The various interrelations of the *Stenotrema* species have been discussed in more or less detail by Bland, Wetherby and Binney. Probably the primary division of the group should be based upon the epidermal sculpture, the first five species of the *Catalogue Amer. L. Shells*—*spinosa*, *labrosa*, *edgariana*, *edwardsi* and *barbigera*, to which *depilata* should be added—having no erect hairs whatever above, but short curved epidermal laminae, running with the growth-lines; while *stenotrema*, *hirsuta* and the rest have either erect hairs above or are nude. Species of the first division are more or less carinated or angular at the periphery, at least in front of the aperture; those of the second division usually are rounded, though sometimes subangular.

This division of the group separates *depilata* from *P. stenotrema*, of which it has hitherto been considered a variety; and as there are several other characters of importance sundering the two, it will be better to treat *depilata* as a distinct species. The distinguishing characters of *depilata* and *stenotrema*, and the varieties of the latter, are shown in the following key:

- a.—Surface with short processes parallel with the growth-lines above, but no erect hairs anywhere; parietal lamella slighter and straighter than in *stenotrema*, the inner end not bending in to meet the basal lip, outer end not passing under the basal lip, when viewed from below; no callous ridge between

the lamella and the peripheral termination of the outer lip; space between lamella and lip wider than in stenotrema; basal lip with a shallow median notch, but no notch or tooth on the outer arc of the lip; fulcrum quite small; spire high; periphery angular; surface hairless, with faint spiral striæ and a silken lustre below.

P. depilata Pils.

a'.—Surface without laminar processes above, bearing erect hairs or none; parietal lamella very strong, crescentic, its inner end curving in and terminating at the axis close to the inner end of the basal lip; outer end also strongly incurved.

P. stenotrema (Fer.), Pfr.

b'.—Surface densely though shortly hirsute or beset with the scars of hairs, both above and below.

c'.—Outer lip with a deep notch for the reception of the outer end of the deeply incurved parietal lamella, a distinct tooth outside of the notch; fulcrum long; form depressed; pale colored. 6 × 10 mm. Woodville, Jackson county, Ala.

P. stenotrema exodon Pils.¹¹

c'.—Outer lip less notched and less distinctly or not toothed; fulcrum decidedly shorter; form more globose, more elevated, and usually dark colored.

Typical stenotrema.

b'.—Surface without hairs or their scars; other characters of typical stenotrema; 6½ × 10 mm. Nashville, Bellevue and Johnson City, Tenn.

P. stenotrema nuda, n. var.

Polygyra depilata Pilsbry.

This species was first found by Mrs. Andrews. It is not closely allied to *P. stenotrema*, with which I formerly associated it, but to *P. edwardsi*. It is known from high up in "Sugar Cove," on the Thunderhead side of Cade's Cove (one specimen); near the summit of Thunderhead, where all our party took specimens, and

¹¹ The names *globosa* (*Nautilus* vi, p. 77) and *subglobosa* (*Catalogue*, p. 14) are to be suppressed. Both are purely *nomina nuda*. As not a word of definition has been published, and as they are quite inapplicable to the depressed variety here defined from Woodville, Ala., no good purpose would be served by their perpetuation. Both typical *stenotrema* and var. *exodon* were collected at Woodville by Mr. H. E. Sargent.

where Mrs. Andrews first found it, and Clingman Dome, near the summit. "Ferriss and I found it on Miry Ridge in 1898, same locality as *P. ferrissii*. Occasionally on trees in moss."—*G. H. C.*

It also occurs on Andrews Bald, a spur of Clingman, in Swain county, N. C., and south of the Little Tennessee river in the northeastern Unaka Mountains, on Stratton Bald (Sargent). In the specimens from this peak, collected not far from the 5,000-foot contour, the notch in the basal lip is shallower and wider from the obsolescence of the callus between it and the axis.

It lives in wet moss and on rocks; not around logs, like our northern *Stenotremes*.

In size it varies but little, the extremes being $9\frac{1}{3}$ – $10\frac{1}{3}$ mm. diam. The conic spire is lower in some individuals, there being sometimes as much as 1 mm. variation in height in specimens of the same diameter. The silky sheen of the surface seems invariable. Some albino specimens from Thunderhead are light green.

***Polygyra edwardsi magnifumosa* n. var.**

Shell small, dark brown and lustreless, often with some golden streaks or spots; the periphery angular in front; whorls $4\frac{3}{4}$ to $5\frac{1}{2}$; the upper surface distinctly wrinkle-striate, not hairy but when unworn showing short cuticular laminae (like those on *P. spinosa*); lower surface smooth, showing fine, slight spiral striae, and sometimes very short hairs or hair-scars. Aperture much as in *P. stenotrema*, the parietal lamella well developed, curving downwards at both ends, a callous ridge running from it to the peripheral insertion of the outer lip; notch of the basal lip median, of moderate size; no tooth developed on the callus within the outer lip. Alt. 4.7 to 5, diam. 7 to $7\frac{1}{2}$ mm.

Brannon's and Chestnut Flats, in Cade's Cove, Blount county, Tenn. (one specimen an albino); Welch Bald, on the Forney Ridge (one specimen), and Welch Bald branch of Chamber's creek (nineteen specimens); Chamber's creek (four), all in Swain county, N. C. Also south of the Little Tennessee river, in Graham county, N. C., on Tuskegee creek (three specimens), and on the Cheoah river, near the confluence of Yellow creek (thirty-one specimens). "Bob's Bald" (three specimens). Clay county, N. C.; at Hayesville (forty-three specimens).

In all, 105 specimens from some eight localities, the extreme

points about forty miles apart. Its vertical range is from about 4,500 feet on Welch Bald to a little below 2,000 feet at Hayesville, Chamber's creek, Cheoah river, etc.

Despite the varying localities, the specimens are remarkably uniform in character. The largest specimen was taken on Chamber's creek, measuring 5.7 mm. alt., 8.8 mm. diam.; otherwise typical. The peculiar sculpture of the upper surface, resembling that of *P. spinosa*, *depilata*, *edwardsi*, etc., and wholly unlike *P. stenotrema* or *P. hirsuta*, amply distinguish it from the latter species. Compared with *P. edwardsi*, described from West Virginia, the var. *magnifumosa* differs in the following features: the parietal lamina is higher, stronger and more sinuous, with a stronger callus between it and the upper end of the peristome; the lip notch is deeper and wider, and the periphery is less angular.

P. edwardsi was collected at Burnside, Pulaski county, Ky., by Messrs. Ferriss and Sargent, the specimens differing from the West Virginians in the well-developed lip notch.

P. barbigera (Redf.).

A single half-grown shell from Hayesville, Clay county, N. C., was taken by Mr. Sargent; and while the peristome is still sharp and simple, the shaggy cuticle, fringed at the sutures, indicates this rare species.

Polygyra stenotrema ('Fer.' Pfr.).

Practically typical specimens occur throughout the region, but in some localities, noted below, huge fellows larger than ever have been recorded were found by Mr. Ferriss. The localities are: Tuckaleechee Cove, and Cade's Cove, including the dependent "Sugar Cove;" Thunderhead, the specimens being very densely hirsute above and below, 9–11 mm. diam., and have an extremely small notch in the basal lip.

Chamber's creek, Swain county, N. C. Diam. varying from 8.7 to 10 mm. Densely hirsute, the notch very small in two, quite large in three specimens, the latter smaller. Another lot from same locality consists of eight very large, densely hirsute specimens, normal in form, varying from $7\frac{1}{2} \times 11$ to 8.2×12.3 mm., whorls $5\frac{1}{2}$ to 6. Some of these shells are the largest I have seen of the species.

Tuskegee creek, Graham county, N. C., small specimens, diam. 9 and 10 mm., the form typical

Tallassee ford of the Little Tennessee river, Monroe county, Tenn. Several large, globose shells, $11\frac{1}{2}$ –12 mm. diam., and some decidedly smaller, $8\frac{1}{2}$ –10 mm. diam.

Yellow creek, Mt. Hayo, Stratton Bald and Glen Cove, Graham county, and Hayesville, Clay county, are other North Carolina localities where Ferriss or Sargent took specimens.

Polygyra hirsuta pilula n. var.

Smaller than typical *hirsuta*, with more elevated spire; whorls nearly 5, the last with well-rounded periphery, surface beset with rather long curved hairs. Parietal tooth sinuous, connected with the peripheral end of the outer lip by a callous ridge. Basal lip 3-toothed, the median notch much deeper than in *hirsuta*, with raised edges, the outer tooth small. Alt. $4\frac{1}{2}$, diam. 6 mm.

The smallest specimens measure, alt. 4, diam. $5\frac{1}{2}$ mm.

Thunderhead Mountain, from near the summit to Cade's Cove.

This form is not only smaller and more globular than *P. hirsuta*, but the armature of the basal lip is different. The median notch is much deeper, and instead of being a mere notch in a straight calloused edge, it appears as a deep sinus between two wide, irregular teeth.

This form seems to be confined to the Great Smoky Mountains. It was first found in June, 1895, by Mrs. George Andrews. Subsequently Messrs. Ferriss and Clapp collected specimens; and the party of five collected it in 1899. We found it in "Sugar Cove," "Lead Cove," "Rowan's" and Laurel creek in Cade's Cove, and on Thunderhead, near the middle summit, among the rocks where *Gastrodonta lamellidens* was found. Sargent found it on Welch Bald, and Ferriss took specimens on Tuskegee creek, below the Little Tennessee river, in Graham county, N. C. It apparently does not descend below 2,000 feet above the sea.

This variety must not be confused with a small form of the species which occurs in the mountains of Pennsylvania, Maryland and Virginia, which is more depressed than var. *pilula*, and has not the peculiar basal lip described above. In the West, Michigan, Illinois, Iowa, etc., a form decidedly larger than that of the Middle States occurs, still retaining the normal shape of the basal lip.

In the region of Roan Mountain, ascending to about 5,000 feet, *P. hirsuta* is represented by another well-marked subspecies, *P. h. altispira* Pils. This form is large, diam. 9, alt. 7 mm., with high, conoidal spire, and broad, deep labial notch. It occurs also in the Black Mountains, N. C. (Hemphill), and in its area apparently replaces the true *P. hirsuta*, as the subspecies *pilula* does in the Great Smokies. It has the habits of *P. depilata*, according to Wetherby, living in damp moss, not under logs and sticks, like the lowland *P. hirsuta*.

Polygyra monodon cineta (Lewis).

Found very sparingly at Chamber's creek Church, on Yellow creek, Cheoah river, in Glen Cove, and at Tallassee ford of the Little Tennessee river. The specimens are nearly typical of the variety, which has more striking peculiarities of form than of color. In the James Lewis collection there are specimens from Hayesville, N. C. It was found to be a very rare shell by Ferriss.

PUPIDÆ.

Bifidaria contracta (Say).

"Sugar Cove" and Laurel creek, in Cade's Cove (Ferriss, Clapp and Walker); Thunderhead (Clapp, one specimen). It is rare in the mountains.

Vertigo bollesiana Morse.

Cade's Cove (Ferriss and Clapp); "Tuskegee Mountains," between Yellow creek and Tuskegee creek (Ferriss). Very rare in the mountains, and apparently quite typical.

Strobilops labyrinthicus strebeli (Pfr.).

Cade's Cove (Clapp *et al.*); Tuskegee creek (Ferriss).

ACHATINIDÆ.

Cochlicopa lubrica (Mull.).

"Sugar Cove" in Cade's Cove, Blount county, Tenn., and "Ramp Cove," between the headwaters of Tuskegee and Yellow creeks (Sargent). Very rare in the mountains, a single specimen found at each of the two localities.

CIRCINARIIDÆ.

Circinaria concava (Say).

Cade's Cove; Thunderhead; Clingman's Dome, to near the summit; Welch Bald; Chamber's creek. South of the Little

Tennessee it was taken by Ferriss on Tuskegee and Yellow creeks, Cheoah river, in Glen Cove, and at Tallassee ford.

After his visit to the mountains in 1898, Mr. Clapp called my attention to the fact that there are two forms of this species in the Smokies, a larger and a smaller. This, however, seems to be a case of wide range of individual variation in size. Thus, of five adult specimens taken in the lily patch near the summit of Clingman, the largest is $15\frac{1}{2}$ mm. diam., with $5\frac{1}{3}$ whorls, the smallest $12\frac{1}{2}$ mm. diam., with $4\frac{1}{2}$ whorls. Two others are $13\frac{3}{4}$ and $14\frac{1}{2}$ mm. in diam.

A larger series taken on Thunderhead, in the Eagle Creek region, N. C., between 3,500 and 4,500 feet, contains larger shells, the measurements of four being $18\frac{1}{2}$, $16\frac{1}{2}$, 15 and slightly under 14 mm. There seems but little variation in the specimens from Cade's Cove, adults measuring about 16 mm. diam. Of course only specimens with the peristome completely developed are considered. Mr. Clapp's note follows:

"Largest from Cade's $18\frac{1}{3}$, smallest $13\frac{1}{2}$ mm. diam. Largest from Thunderhead, $20\frac{1}{2}$ mm., with 5 whorls; smallest, 14 mm., with $4\frac{1}{2}$ whorls. The small shells have a proportionately wider umbilicus. It may be merely an optical illusion, but the last whorl of the small shells appears to be subangular around the umbilicus. A specimen from Philadelphia, Loudon county, Tenn., in the Lewis collection, measures $22\frac{1}{3}$ mm. diam."

ZONITIDÆ.

Omphalina fuliginosa polita Pils.

Fine specimens up to 28 mm. diam. occur in Cade's Cove. Those from Thunderhead, near the summit, are not so large, diam. 25-26 mm. Mr. Ferriss took it also at Chamber's Church, at the mouth of Chamber's creek, Swain county, N. C. In 1898 Clapp collected specimens along the bluffs of Little river, in Tuckaleechee Cove. They are much smaller than the Great Smoky shells, the largest being only 20 mm. in diam.

Omphalina lævigata ('Raf' Beck).

Mesomphix lævigata Raf., Beck, Index Molluscorum, p. 7, 1837.

Helix lævigata Fér., Pfr., et auct., not *Helix lævigata* Pennant, 1777.

The name of this species has been long preoccupied as a *Helix*, but I propose to avoid the obloquy of changing it by dating it

from Beck, who really first defined the species by a reference to Férussac's figures, and whose publication was anterior to that of Pfeiffer, who has generally been cited as authority for the name. The synonymy has been ably discussed by Mr. W. G. Binney, who, however, does not credit Beck with the name. The type locality is "Kentucky."

Not uncommon in Cade's Cove, attaining 20 mm. diam. Those from high on Thunderhead are rather smaller; the color being decidedly green. Mr. Clapp took one specimen on the west end of Clingman. Mr. Ferriss took duskier specimens on the Cheoah river, Graham county, N. C.

Two notable varieties occur near the Little Tennessee river.

O. lævigata perlævis n. v.

Whorls more convex beneath than in typical *lævigata*, the *last whorl much smoother above*, not rib-striate, its width at the aperture (measured above) less than one-third the diameter of the shell. Aperture rounded-lunate, almost as high as wide. Alt. $9\frac{1}{2}$, diam. 17 mm. This is from Tallassee ford of the Little Tennessee river, Monroe county, Tenn.

Omphalina lævigata latior n. v.

Broad and depressed, more broadly excavated around the umbilicus than the typical form, *the last whorl wider*, its width at aperture (measured above) one-third the diameter of the shell, and far smoother than in *lævigata*, being wrinkled irregularly, but without the close, deeply cut and subregular rib-striæ of the typical form of that species. Aperture oval-lunate, far wider than high. Color yellowish green. Alt. $13\frac{1}{2}$, diam. 24 mm., or as large as 14×27 mm.

Tallassee ford, Little Tennessee river, Monroe county, Tenn.; also Chamber's creek Church, at junction of Chamber's creek with the Little Tennessee river.

A large, flattened and very green form, in which the rib-striæ are obsolete on the last whorl, and the aperture decidedly oval. In *O. l. perlævis* the base is more convex around the umbilicus, the mouth much more nearly round, and the last whorl narrower. *O. l. latior* has an elegant microscopic sculpture, which gives the upper surface a somewhat silky lustre.

Omphalina subplana (Binney).

In this species the apex and inner whorls are striated, as in *O. lævigata*, not smooth as in *inornata*. Splendidly developed specimens occur in the Smokies; the largest taken by myself in Cade's Cove measuring $21\frac{1}{2}$ mm. diam. On the flanks of Thunderhead equally large specimens occur nearly to the summit, one in Clapp's collection measuring $23\frac{1}{3}$ mm. diam. A clear green albino is among those collected there. As on Roan Mountain, it lives with *Vitrinizonites*, but is not rare. The shells are hard to clean, scarcely ever "pulling" well.

It occurs, but rarely, on Clingman's Dome. Ferriss took specimens on Block House Mountain and Welch Bald, and south of the Little Tennessee river on Tuskegee creek, Cheoah river, Mt. Hayo and in Glen Cove.

Omphalina andrewsæ Pillsbry.

A very characteristic shell of the Great Smokies in Blount county, replacing here the *O. inornata* of the Cumberland Plateau. The largest taken by myself in Cade's Cove is 16 mm. diam., but Clapp took one $17\frac{1}{2}$ mm. diam. On Thunderhead, near the summit (about 5,400 feet), they are smaller, diam 12 mm., and rather thinner. Specimens with a dark band above the periphery occasionally occur. It is one of the most beautiful shells of the region. Specimens were taken by Clapp on Miry Ridge, in 1898, diam. of the largest 17 mm. Also collected by Ferriss on Block House, Clingman's, Welch Bald, Welch Bald branch, Chamber's creek, and south of the Little Tennessee river on Tuskegee creek, Cheoah river, Mt. Hayo, in Glen Cove, and at Tallassee ford. It therefore seems generally distributed in the Great Smokies and northeastern Unakas.

O. andrewsæ montivaga Pills.

This form seems to show no intergradation with *andrewsæ*, and is chiefly notable for the prolonged form of the aperture. The largest taken in Cade's Cove measures 19 mm. diam., and it is usually over 17. They are smaller, 15 to 17 mm., near the summit of Thunderhead. Mr. Ferriss took specimens on Welch Bald and Chamber's creek, and south of the Little Tennessee on Cheoah river. Clapp took it in 1898 on Miry Ridge, diam. $18\frac{2}{3}$ mm.

Vitrinizonites latissimus (Lewis).

Slopes on south side of Cade's Cove, about 2,000–2,500 feet elevation; near summit of Thunderhead, lurking in deep moss covering the damp rocks; Block House Mountain, just south of Thunderhead; Clingman's Dome, not far from the summit, in moss, on the *Polygyra ferrissii* and *P. andrewsæ altivaga* ground; Welch Bald; and below the Little Tennessee, Ferriss took one specimen on Stratton Bald, in the northeastern part of the Unaka range.

The species is ubiquitous in the Great Smokies everywhere above 2,000 feet, though not found in great numbers, and restricted to moist places where moss carpets the rocks or logs. These conditions are met on the lower levels where the mountain slopes are densely shaded, but on the cloud-touched heights not much shade is necessary.

The shell of *V. latissimus* is often deficient in calcareous stiffening in the region near the axis behind the columella, and it is more or less shrunken or dented there. This is a significant feature, showing that *Vitrinizonites* is varying toward the condition of shell we find in *Cryptostrakon*, *Peltella*, *Gæotis* and some forms of *Girasia*,¹² in all of which decalcification has affected the same region of the shell. The following form, however, shows more impartial decalcification, or, to be more exact, want of calcification.

Vitrinizonites latissimus uvidermis, n. var.

Near the summit of Thunderhead and Clingman's Dome, in the wet moss covering the rocks, there lives a form of *Vitrinizonites* of about the size of *latissimus*, but almost wholly lacking any calcareous layer of the shell. The cuticular test is more or less dented and distorted in the living snails; and when "cleaned" the shell collapses like wet paper, unless stuffed with cotton. The surface is usually less brilliant than in *V. latissimus*, and the last half-turn of the suture deviates somewhat more tangentially. The color varies from as light as the ordinary *V. latissimus* of the region to a very dusky, even blackish, shade. These "grape-skin *Vitrinizonites*," as we called them, live with the normal form, but are apparently always easily distinguished as above indicated. A cleaned shell quite resembles the empty skin of the ordinary free-

¹² See *Manual of Conchology*, XII, second series, p. 211.

skinned Concord grape. The form was first found by Ferriss and Clapp in 1898. It is not improbable that a study of the soft parts, which I hope to find time for before long, will show it to differ specifically from *V. latissimus*.

Vitrea petrophila pentadelphia n. var.

Shell about the size of *V. indentata*; glossy, pink-brown, openly umbilicated, convex above, composed of $4\frac{1}{2}$ whorls, those of the spire slowly widening, the last much wider; surface sculptured with many unevenly spaced radiating grooves similar in character to those of *V. indentata*, but more numerous; and there are some striae intermingled, the spire being more closely striate. No mentionable spiral striae seen with an enlargement of fifty diameters. The grooves continue upon the base, but are weaker there. Aperture broadly lunate. Alt. $2\frac{1}{2}$, greatest diam. 5 mm.

Cade's Cove, Blount county, Tenn., in many places—"Roe's" and "Sugar" Coves, "Rowan's" and Laurel creeks—from about 1,800 to 2,200 feet elevation. Apparently wanting in the higher region, at least not found by us along the crests and peaks; but taken by Ferriss and Sargent on Stratton Bald, in the Unaka Mountains, Graham county, N. C., at what altitude not known, and at or below the level of Cade's Cove on the Cheoah river, near the junction of Yellow creek, and in Monroe county, Tenn., at Tallassee ford of the Little Tennessee river, near Caringer.

This *Vitrea* may be briefly characterized as similar to *V. petrophila*, but with only $4\frac{1}{2}$ instead of $5-5\frac{1}{2}$ whorls in shells of the same size, slightly wider umbilicus, less embracing and therefore less deeply lunate aperture and usually pinkish instead of whitish-corneous color. *V. rhoadsi* is a smaller shell with decidedly narrower umbilicus.

V. petrophila is not known to occur in the Great Smoky Mountains.¹³ Judging from specimens taken by Mr. Clapp and myself at Knoxville, Tenn., and part of the original lot received from Bland, as well as other specimens collected by Ferriss and Sargent at Burnside, Ky., that species is very constant in characters. *V. p. pentadelphia* seems equally constant in the considerable number I have now seen, collected by Mrs. Andrews and the members of

¹³ The form reported thence in the *Catalogue of American Land Shells*, p. 27, No. 263, was var. *pentadelphia*.

our party of 1899. It is the memory of this journey of five conchologists which the name seeks to perpetuate.

Vitrea carolinensis (Ckll.).

This species has been discriminated from *V. sculptilis* in the published accounts, but it is very much more closely allied to *V. indentata*. Indeed, it becomes an extremely difficult matter to separate the smaller form of *carolinensis*, such as prevails in the Great Smoky Mountains, from *V. indentata*. There is, however, one usually decisive criterion: *V. carolinensis* when examined with a *very strong* hand-lens, or, better, a compound microscope with an enlargement of 25 or 50 diameters, shows a minute sculpture of *very even, close, clear-cut spiral engraved lines*. In *V. indentata* the same magnification only brings out an extremely weak striation or none; only rarely does it approach the condition of *V. carolinensis*.

This micro-sculpture is so minute that an ordinary pocket lens, even a very good one, rarely reveals it. But I have seen very few specimens which could not be definitely referred either to *carolinensis* or *indentata* when examined with a compound microscope. The sculpture is visible only in the "high-light" or point of reflection.

Common throughout the Great Smoky ranges wherever explored. In Cade's Cove and the dependent valleys it has been taken in many places: Rowan creek, diam. 6 mm.; "Brannon's"; "Chestnut Flats," diam. 6 mm.; Laurel creek, diam. $5\frac{1}{2}$ to $7\frac{1}{2}$ mm.; "Sugar Cove," diam. 6 mm.; most of these having been collected by Ferriss; the localities lying between 1,800 and 2,200 feet.

On Thunderhead, near the summit, at 5,300–5,400 feet, on Block House Mountain, and on the western end of Clingman Dome, 6,000 feet, they measure 5 to 6 mm. diam.; Welch Bald, diam. $6\frac{1}{2}$ mm.; and on Chamber's creek, adults 5 to 6 mm. diam.

South of the Little Tennessee river specimens were taken by Ferriss and Sargent on Tuskegee creek and Cheoah river, diam. 7 mm.; Hayesville, diam. $5\frac{1}{2}$ mm.; Stratton Bald, in the north-eastern Unakas, alt. about 5,000 feet. In Monroe county, Tenn., it occurred at Tallassee ford, diam. $6\frac{1}{2}$ mm.

It was taken on Miry Ridge in 1898 by Clapp, whose largest specimen measures $8\frac{1}{2}$ mm. diam.

Besides these mountain localities, Mr. Clapp collected *V. carolinensis* at Oakdale, Morgan county, Tenn., and Mr. Ferriss obtained at New Pittsburg, Tenn. ($6\frac{1}{2}$ mm. diam.), and at Burnside, Ky., diam 6 to 7 mm. I found a specimen among shells Clapp and I collected on the south side of the Tennessee at Knoxville.

***Vitrea sculptilis* (Bld.).**

This strikingly distinct species was taken in Cade's Cove and on Thunderhead Mountain, up to the spot near the summit where *Gastrodonta lamellidens* was found. The largest from this locality is 7 mm. diam. Ferriss and Sargent add the localities Block House, Andrew's Bald, Chamber's creek, in Swain county, and Cheoah river and Stratton Bald in Graham county, N. C. Also Tallassee ford and Welch Bald. It was described from somewhat below these localities, in the Anantahely Mountains, N. C.

Under a strong lens the surface of this species is seen to be granulose in spiral series, and the edges of the radial grooves seem somewhat raised. This is usually more prominent on the spire than on the last whorl.

***Vitrea capsella* (Gld.).**

Probably most of the examples from the Great Smokies are referable to the variety *placentula*, which is larger than typical *capsella*, with an additional whorl; but one lot of seven shells from "Sugar Cove," off Cade's Cove, is typical *capsella*. The largest shell measures 5 mm. diam., and has $6\frac{1}{3}$ whorls. Sargent took it in "Ramp Cove," on Tuskegee Mountain, between the headwaters of Tuskegee and Yellow creeks, in Graham county, N. C.

***V. capsella placentula* (Shuttl.).**

Cade's Cove; Thunderhead near summit, a little smaller. It occurs also on Chamber's creek, Swain county, N. C. It is very difficult to draw a line between *capsella* and *placentula*.

***Conulus chersinus* (Say).**

Cade's Cove (Ferriss and Clapp).

***Zonitoides arboreus* (Say).**

Cade's Cove, at many points (Laurel and Rowan's creeks, Roe's, Brannon's, etc.), but not common; Thunderhead, at Spencer's Cabin, under dried cow-dung, and near Eagle Creek; Block

House Mountain, south of Thunderhead; west end of Clingman, at about 5,800 feet, on logs. Chamber's creek and Welch Bald, Swain county, and south of the Little Tennessee on Tuskegee creek, Graham county (Ferriss and Sargent), and at Hayesville, Clay county (Sargent). Also Tallassee ford. It is common at Knoxville. Seems to occur throughout the mountains, though far more sparingly than on lower country, and apparently varies from the Northern shells in being somewhat smaller and frequently more widely umbilicated.

Zonitoides patuloides (Pilsbry).

I found one specimen under chips in Cade's Cove, on the Thunderhead trail. Ferriss and Clapp took one or two specimens each in various parts of Cade's Cove in 1898, and Sargent in 1899. It is one of the rarest snails.

Zonitoides elliotti (Redfield).

Cade's Cove; Thunderhead near the summit; Welch Bald and Welch Bald branch; Chamber's creek, down to the Little Tennessee, south of which Ferriss and Sargent took specimens on Tuskegee creek, Cheoah river and Mt. Hayo. Also Stratton Bald and Hayesville, N. C. (Sargent).

Z. elliotti is evidently allied to the preceding species, not to the *Gastrodontas*, where I formerly placed it. It has the foot-grooves and caudal pore of the *Zonitidae*, as Binney has stated, and the resemblance of the shell to *Circinaria* is therefore meaningless.

Messrs. Ferriss and Sargent took specimens of *Zonitoides lateumbilicatus* Pils. at Burnside, Pulaski county, Ky. This species has not hitherto been reported from elsewhere than the type locality in Jackson county, Ala., where it was discovered by Mr. H. E. Sargent.

GASTRODONTA.

The genus *Gastrodonta* is a most interesting one to the evolutionist, presenting a considerable number of local forms. These are of all grades between the slightest deviation from the historic types of the species and strongly marked subspecies, or forms which apparently could be called specific. Taking the group (exclusive of *Taxeodonta*) as enumerated in the Catalogue recently published by the *Nautilus*, it divides naturally into three parts: the group of *G. ligera*, containing *intertexta*, *acerra*, *demissa*,

cerinoidea and *ligera*; the group of *G. gularis*, containing *collisella*, *gularis*, *suppressa*, *cælaxis*, *lawæ* and *lasmodon*; and finally the group of *G. interna*, comprising that species alone.

“*G. elliotti*” evidently does not belong here, but to *Zonitoides*, next to *Z. patuloides*; and *G. macilenta* (Shuttl., not W. G. Binn.) is a synonym of *G. lasmodon*. It is often an excessively difficult matter to separate young *G. gularis* from *G. suppressa*, yet they cannot reasonably be united specifically.

***Gastrodonta intertexta* (Binn.).**

Cade’s Cove, Blount county, Tenn. Also taken by Ferriss on Welch Bald branch, Chamber’s creek and Tuskegee creek, and by Sargent at Hayesville, N. C. Clapp found one specimen, an albino, on the west end of Clingman.

***Gastrodonta acerra* (Lewis).**

Commonly distributed in the Smokies. Cade’s Cove (variable in size and form, measuring from alt. 10, diam. 16, to alt. 11, diam. 14 mm.; the high bee-hive shaped form prevailing); Thunderhead (5,400 feet) and Clingman Dome (6,500 feet), somewhat thinner and smaller, diam. 12–13½ mm.; and in North Carolina at Welch Bald, Chamber’s creek, in Swain county, and south of the Little Tennessee river on Cheoah river, Mt. Hayo, and in Glen Cove, Graham county, and Hayesville, Clay county, N. C.; also at Tallassee ford, Monroe county, Tenn. (Ferriss and Sargent).

The form of *acerra* prevalent in the mountains is generally smaller and more elevated than Dr. James Lewis’ specimens from Monroe county, Tenn., and the last whorl seen from above is not so wide. Occasional specimens, however, may be found almost exactly like the Monroe county shells, though the average or norm of the mountain shells is perceptibly different.

Mr. Walker got a sinistral specimen in Cade’s Cove.

***Gastrodonta demissa* (Binn.).**

Rowan creek, Cade’s Cove, with *G. gularis** (Ferriss). Also taken at Chattanooga, Tenn., by Mr. Ferriss, and at Stratton Bald, Graham county, N. C., and Harriman, Tenn, by Mr. Sargent.

***Gastrodonta gularis* (Say).**

The very large series examined shows considerable variation in height of the spire, but is constant in the barely perforated um-

bilicus. The teeth vary as usual, often curving strongly toward each other, but sometimes nearly straight. The same sort of shell prevails throughout most of the localities thus far explored in the Great Smokies, about 400 shells from that region having been individually examined.

The localities are as follows: Monroe county, Tenn., Tallassee ford, and on Citico creek; Blount county, Cade's Cove, in many places. Along the Tennessee-North Carolina boundary at Thunderhead and Clingman's Dome. Swain county, N. C., at Welch Bald and on Chamber's creek; Graham county, N. C., on Tuskegee creek and Cheoah river, and on Stratton Bald (5,000 feet). At Hayesville, Clay county, N. C. (slightly below 2,000 feet), a series of over 100 specimens collected by Sargent shows somewhat more variation than occurs in the other localities enumerated above. The umbilicus varies from a very minute perforation in nearly all examples to one about .8 mm. wide in a very few; and of two specimens with a diam. of 8 mm., one is $5\frac{1}{2}$ mm. high with fully 8 whorls, another $4\frac{1}{3}$ mm. with 7 whorls. All intermediate contours occur. The high examples do not have the full basal whorl of *G. collisella*, and are true *gularis* in the mouth parts.

Gastrodonta interna (Say).

Apparently does not occur abundantly in the mountains along the Tennessee-North Carolina boundary. Ferriss found it on Welch Bald, Chamber's creek Church, and south of the Little Tennessee on Tuskegee creek, Cheoah river and Bob's Bald.¹⁴

Section **TAXEODONTA.**

This little group comprises the thin little Gastrodonts allied to *G. multidentata*. Comparison of the shells and soft anatomy should be made with the toothed *Conulus* and with certain toothed individuals of the *V. capsella* group. Aside from these, the group stands well apart from others. *G. significans* and *G. andrewsæ* are comparatively large and robust forms, the former widely distributed and with teeth in pairs, the latter belonging to the Roan Mountain region, and with numerous teeth. Then we have in the Great Smokies several peculiar species:

¹⁴ Ferriss lists *G. interna* from "Brandon's Cove," probably Brannon's Cove, subsidiary to Cade's Cove.

Gastrodonta clappi Pilsbry.

Described from Miry Ridge, where it was taken by Ferriss and Clapp in 1898, but most of the few shells taken that year were found at the *lamellidens* locality on Thunderhead. In 1899 we found it at the western end of Clingman, at about 5800 feet alt., on wet stones some distance below the surface. Mr. Ferriss found a single half-grown but unmistakable specimen on Block House Mountain, a peak nameless on the Geological Survey topographic map, lying south of Thunderhead; and Sargent took specimens on Thunderhead, in the *G. lamellidens* locality.

No specimens yet seen, either old or young, have internal teeth or barriers. It is very distinct from the following forms by its much larger size and conspicuously coarser sculpture, wider whorls, etc. The type measures, alt. 3, diam. 5.5, width of umbilicus .23 mm., whorls $6\frac{1}{2}$. The spire is slightly raised. The Thunderhead examples agree with the type in having a very small umbilicus, the spire being slightly convex. A specimen taken by Clapp on Clingman measures, alt. 3, diam. 6.2, width of umbilicus .54 mm., whorls $6\frac{1}{2}$, the spire nearly plane. Below "The Balsams" on the western end of Clingman, a few hundred feet down the Tennessee side, I found two half-grown specimens of about 3.8 mm. diameter, also having the umbilicus somewhat wider than in the Miry Ridge type, though less wide than Clapp's specimen, and the spire nearly flat. It is unsafe to draw conclusions from the three specimens thus far known from Clingman, but perhaps that peak has a race with more depressed spire and wider umbilicus.

Four localities are now known for this species, the Thunderhead, Miry Ridge and Clingman shells coming from a little north of the interstate boundary, in Tennessee, the Block House shell from south of the boundary, in North Carolina. None of the localities are far from the 5,000-foot contour, and the extremes lie about thirteen miles apart. The shells are extremely fragile, like most forms living on the Clingman and Thunderhead conglomerates.

The most assiduous search by our party of five in 1899 resulted in finding fourteen specimens, most of them immature. About as many were found by Messrs. Ferriss and Clapp in 1898.

G. lamellidens Pilsbry.

A very glossy and brilliant, dark reddish-brown shell, with the closely coiled whorls and size of *G. multidentata*, but differing from that species in never having radial rows of teeth, but having obliquely radial laminæ, three in young, rarely more than one or two in adult shells. This armature is constant in a large number of specimens that I have examined, collected by Ferriss, Clapp and myself.

Mr. Clapp has a similarly armed shell, very light colored but otherwise typical, from Deering, N. H., collected by Mr. E. W. Roper, and there is one (No. 57,106) in the collection of the Academy from Greenwich, N. Y. The question arises, are these not mere occasional variations of *G. multidentata*, which appear sporadically, rather than a distinct species? In this case *lamellidens* is to be regarded as a race in which this rare variation has become a fixed and, so far as can be proved by about 150 shells examined, probably a constant character. And in this connection the possible relationship to these forms of *Conulus dentatus* Sterki, which has similar armature, needs investigation.

In *G. lamellidens* the surface shows no spiral striation under an enlargement of 50 or 75 diameters; it is rather deeply, closely and regularly costulate-striate; and the width of the umbilicus is contained about ten times in the diameter of the shell.

The type locality¹⁵ is a steep slope close to the middle summit of Thunderhead, deeply covered with a talus of angular stones small and large, in the interstices of which there is considerable mould which supports a herbaceous growth. *Vitrinizonites*, *Gastrodonta acerra* and a few *Polygyra depilata* are the chief dwellers among the moss of the superficial stones, but, as Ferriss wrote last year, a "quarry" must be opened to find *G. lamellidens*. Each one of the wet stones must be closely examined on all sides before it is thrown out, and once in a long while one or two of the snails may be found, if one is in luck. They occur from a few inches to a foot or more below the surface of the talus.

Specimens have also been found by Mr. Ferriss at Block House Mountain (near and south of Thunderhead), Swain county, and at

¹⁵ By an error of my own, the locality "Clingman's Dome" was given in the *Classified Catalogue*, p. 29. No specimens are yet known from Clingman, though it will probably be found there.

Stratton Bald and on the Cheoah river, Graham county, N. C.; Sargent also took it at Stratton Bald.

Gastrodonta walkeri n. sp.

Size of *G. lamellidens*, and general contour about the same; whorls $5\frac{3}{4}$; umbilicus much wider and more open, its diameter contained about $5\frac{1}{2}$ times in that of the shell; *surface rather dull to the naked eye*, under strong magnification seen to be extremely finely and irregularly plicatulate-striate, *the striae cut into minute beads by close decussating, impressed, encircling lines*. No internal aminæ or teeth in adults, or with two transverse, curved barriers, as in *G. lamellidens*. Alt. 1.45, diam. 2.9, width of umbilicus 5 mm.

Cheoah river, near junction of Yellow creek, Graham county, N. C., three specimens taken by Ferriss. "Ramp Cove," on Tuskegee Mountain, between the heads of Tuskegee and Yellow creeks, several taken by Sargent.

This form differs from *G. clappi* in the sculpture and in size. It resembles *G. lamellidens* and *multidentata*, but is ornamented with densely crowded spiral lines, and very conspicuously finer growth-striae, and has a wider umbilicus. A half-grown specimen of the type lot has two curved internal laminæ, like *G. lamellidens*, with finely denticulate edges; the others have no internal armature. Four specimens from Tallassee ford of the Little Tennessee, Monroe county, Tenn., have the spirals rather more spaced, and each has two internal denticulate transverse laminæ; umbilicus about one-seventh the diameter of shell.

Of the specimens taken by Sargent, one from Ramp Cove has an internal barrier, another none; and those from Sam. Blair's, at Tallassee Ford, vary in the same way. The decussated sculpture is constant.

The species will be most easily recognized by the finer radial sculpture and wider umbilicus than *lamellidens*, as the spirals are nearly or quite invisible under an ordinary lens, though their development is an essential specific character.

G. multidentata (Binn.).

Oakdale, Morgan county, Tenn., one specimen (Clapp). Though not in the Great Smoky Mountain area, this is included as showing the southward distribution of the species.

G. signifoans (Bld.).

"Ramp Cove, Tuskegee Mountain," between the headwaters of Tuskegee creek and Yellow creek. Typical specimens taken by Ferriss and Sargent.

LIMACIDÆ.

Agriolimax campestris (Binn.).

Thunderhead Mountain, near the summit, common.

PHILOMYCIDÆ.

Philomycus carolinensis (Bosc.).

Tuckaleechee and Cade's Coves, Blount county, Tenn.; Thunderhead, to the summit, crawling on trees; Clingman's Dome.

This species is common throughout the Great Smoky Mountains, and the individuals reach a very large size. In the humid atmosphere of the mountain tops *Philomycus* lives in the open, on trees and logs, not concealed beneath the bark, as in dryer localities.

Philomycus hemphilli (W. G. Binney).

"Sugar Cove," in Cade's Cove, at over 2,000 feet elevation; Thunderhead, near the summit, on moss, etc.; Clingman's Dome.

The coloration of this species reminds one of *Amalia hewstoni*, the back being black, fading on the sides to whitish beneath. The jaw in a specimen examined has a group of four contiguous ribs near the middle. The specimens collected were drowned, but all collapsed in alcohol; and probably some other method of preservation would be better.

ENDODONTIDÆ.

Pyramidula alternata (Say).

Andrews Bald; Welch Bald, Cheoah river, Tuskegee creek and Mt. Hayo, N. C. At Glen Cove, Unaka Mountains, Graham county, N. C. (Ferriss), a distinctly depressed form, but not more carinated than typical shells, occurred.

Typical specimens of *P. alternata carinata* Pils. were taken by Ferriss at Burnside, Pulaski county, Ky. Large specimens, up to 22 mm. diam. This form is very strongly carinated, but rather more finely ribbed than typical *alternata*. See *Proc. Acad. Nat. Sci. Phila.*, 1896, p. 490. The types of the variety were taken by Mr. S. N. Rhoads, on the Emory river, near Harriman, Tenn. It is a race of the Cumberland Plateau.

***Pyramidula alternata costata* Lewis.**

We took this strongly marked variety in Cade's Cove and on Thunderhead. It has not been found elsewhere (see Clapp, *Nautilus*, XIII, p. 41). Ferriss found a sinistral specimen in Sugar Cove, off Cade's.

***Pyramidula perspectiva* (Say).**

Cade's Cove; near summit of Thunderhead, and near summit of Clingman's Dome. Ferriss adds the localities Welch Bald, Chamber's creek, Tuskegee creek, Cheoah river, Mt. Hayo and Tallassee ford. Typical, and in Cade's Cove very abundant, under slabs at an old saw-mill, near Blair's place. Beautiful albino specimens were found in "Sugar Cove." *P. bryanti* does not appear to occur in the Great Smokies.

***Helicodiscus lineatus* (Say).**

The mountain specimens are well developed, but practically typical. Specimens were taken in Cade's Cove at various points, near the summit of Thunderhead, at Block House, on the west end of Clingman, and south of the Little Tennessee on the Tuskegee Mountains, north of Tuskegee creek, on Bob's Bald and on Mt. Hayo.

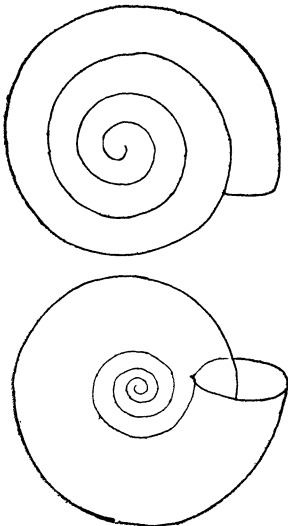
***Punctum blandianum* n. sp. Fig. 1.**

Fig. 1.

Mr. Clapp found two specimens of *Punctum* somewhere in Cade's Cove (probably in the dependent "Sugar Cove") which differ markedly from *P. pygmæum*. The umbilicus is much wider than in *P. pygmæum*, its width contained between $2\frac{2}{3}$ and $2\frac{3}{4}$ times in the total diam. of the shell. The aperture is smaller than in *P. pygmæum*. Whorls $3\frac{1}{2}$; color brown; surface-sculpture about as in *P. pygmæum*—very fine but rather sharp striæ along the growth-lines and nearly obsolete spiral striæ. The spire is low conoidal, about as in *P. pygmæum*.

Alt. .6, diam. 1.15 mm.

It is named in honor of Thomas

Bland, whose excellent work on American land shells materially advanced the science.

SUCCINEIDÆ.

Succinea obliqua (Say).

A rather thin form of this species occurs near the summit of Thunderhead, on leaves of herbage. Also found on Clingman's Dome.

PLEUROCERATIDÆ.

The mountain streams above two or three thousand feet in the Great Smokies are apparently barren of molluscan life, though full of trout. The following occurred at lower levels.

Pleurocera aratum (Lea).

Little Tennessee river, at Tallassee ford, Monroe-Blount counties, Tenn. (Ferriss).

Pleurocera hastatum (Anth.).

Little river in Chilhowee Gap, Blount county, Tenn. (Walker, Clapp and Pilsbry).

Goniobasis proxima (Say).

Welch Bald branch of Chamber's creek, Swain county; Tuskegee creek, Graham county; and Mission creek, Hayesville, Clay county, N. C. (Ferriss and Sargent).

Goniobasis saffordi (Lea).

Chamber's creek, Swain county, N. C. (Ferriss).

APPENDIX.

In *The Nautilus* for January, 1898, Prof. W. H. Dall mentions, without description, a new variety of *Vitrea wheatleyi* under the "varietal name of *V. clingmani*," based upon "the large form of *Z. wheatleyi* referred to by Binney (*Manual*, p. 222) as collected by Hemphill at Clingman's Peak, N. C."

When on Clingman Dome, our party searched diligently for this shell, but without success. On applying to Mr. Hemphill for information, I learned that the "Clingman's Peak" of his label is not Clingman Dome of the charts, but a local name for a peak northeast of Asheville. Hemphill did not visit the Great Smoky range. He writes as follows:

"Black Mountain Station is on the railroad east or northeast of Asheville. From this station I walked into the mountains (north) about ten or twelve miles and stopped at a house near the foot of Mt. Mitchell, and also near the Pinnacle of the Blue

Ridge. In company with two other persons, I went to the summit of Mt. Mitchell and 'Clingman's Peak,' as they called it, and remained all night. We carried our provisions and blankets. It took nearly all day to get to the summit, and I had but a few hours for collecting the next morning. If my memory serves me faithfully, I got but little material on that trip, but judging by the name, I suppose the shell called *Z. wheatleyi clingmani* was collected at that place and time."

The specific name does not of course refer to the mountain, but is to honor Thomas L. Clingman, who made valuable observations on the geology and topography of North Carolina, and further served that State with distinction in the U. S. Senate, before the civil war.

The following diagnosis and *camera lucida* outlines have been supplied by Prof. Dall:

"*Vitrea clingmani* Dall. Fig. 2.



Fig. 2.

"Shell extremely thin and fragile, of a translucent greenish color, polished, with five rather inflated whorls; suture well marked, the enveloping whorl rising slightly above it and not suturally appressed; sculpture in harmony with the incremental lines, consisting of at first rather close-set regular wrinkles which are obsolete on the base and more distant in the adult near the last part of the last whorl; spire and base somewhat flattened, periphery rounded, peristome acute, the upper lip but little produced beyond the basal part; umbilicus narrow, deep; nucleus very small, smooth;

major diam. 6.5, minor diam. 5, alt. 2.5 mm.

"Habitat, Black Mountain, N. C., near Clingman's Peak, Hemphill. Types 38,910, U. S. Nat. Mus.

"This form was referred to *Zonites wheatleyi* by Binney, from whose original specimens this diagnosis is drawn, but, as pointed out to me by Dr. Pilsbry, the species to which our shell is most closely allied is *Vitrea petrophila*. The latter is of a waxen whitish or pale straw color verging toward brownish, but *V. clingmani* is distinctly greenish; *V. petrophila*, though a smaller shell, has, in all the specimens I have been able to examine, a larger and more funicular umbilicus, and the lumen of its whorls is more circular."